Research Note

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RESPONSE OF GRAND FIR, WESTERN HEMLOCK, WESTERN WHITE PINE, WESTERN LARCH, AND DOUGLAS-FIR TO NITROGEN FERTILIZER IN NORTHERN IDAHO

by

Russell T. Graham and Jonalea R. Tonn[1]

ABSTRACT

*Two study areas were used to assess the response of mixed, young, coniferous forests to nitrogen (N) fertilizer in the form of urea. Significant (P<0.05) responses in diameter growth to fertilization were noted at one of the study areas. Significant differences were detected between the height growth means in both study areas. Differences between the height and diameter growth means for the 200 lb N per acre (224 kg N per ha) treatment and the 400 lb N per acre (448 kg N per ha) treatment were not significant. When each species was analyzed separately only grand fir (*Abies grandis [*Dougl.*] *Lindl.*) and Douglas-fir (*Pseudotsuga menziesii *var.* glauca [*Beissn.*] *Franco*) had a significant response to fertilizer application.*

KEYWORDS: Fertilization, western white pine, grand fir, diameter growth, height growth.

Past studies indicate that fertilization may have potential as a silvicultural tool in young forests in northern Idaho. Loewenstein and Pitkin (1963) reported height growth increases (compared with elongation prior to fertilization) as high as 286 percent for grand fir (*Abies grandis* [Dougl.] Lindl.) and 187 percent for western white pine (*Pinus monticola* Dougl.). Ryker and Pfister (1967) also showed a significant growth response to fertilizer in western white pine in thinned stands. More information is needed on the amount and duration of response that can be expected from various levels of fertilizer applications. Additional information concerning which species have the greatest potential to respond to fertilization is also important. The objective of this trial was to study the effects of urea fertilization on growth characteristics in a young stand of mixed conifers. This paper reports on diameter and height growth responses of five conifers.

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[1]Research forester and forestry technician, respectively, located at the Intermountain Station's Forestry Sciences Laboratory, Moscow, Idaho.

STUDY AREAS

Fertilization trials were established at both the Deception Creek Experimental Forest (DCEF) and the Priest River Experimental Forest (PREF). Both studies were in young natural stands of mixed conifers in the *Tsuga heterophylla/Pachistima myrsinites* habitat type (Daubenmire and Daubenmire 1968).

The DCEF study occupies 4.5 acres (1.8 ha) on a north-facing slope in lower Snyder Creek. The lower half is on gentle slopes; however, the upper half has slopes up to 50 percent. The stand was seed-tree cut in 1952, and the seed trees were removed in 1965.

In 1971, the stand was cleaned to a spacing of approximately 10 feet (3.05 m) by 10 feet (3.05 m). An effort was made to leave a mixture of species including:

western white pine (*Pinus monticola* Dougl.)
western larch (*Larix occidentalis* Nutt.)
Douglas-fir (*Pseudotsuga menziesii* var. *glauca* [Beissn.] Franco)
grand fir (*Abies grandis* [Dougl.] Lindl.)
western hemlock (*Tsuga heterophylla* [Raf.] Sarg.)
Engelmann spruce (*Picea engelmannii* Parry)
subalpine fir (*Abies lasiocarpa* [Hook.] Nutt. var. *lasiocarpa*)

The DCEF study area was fertilized in the fall of 1972. At the time of fertilization the stand had a mean diameter of 1.48 inches (3.76 cm) and a mean height of 10.64 feet (3.24 m). The cleaning resulted in a stand containing 370 trees per acre (913.6 trees per ha).

The PREF study area consists of 3 acres (1.2 ha) in the lower part of the Benton Creek Drainage. The stand originated in 1955 after removal and dozer-clearing of the previous stand. The slope percent ranges from 25 to 35. In the fall of 1971, the stand was cleaned to an average spacing of 12 feet (3.66 m) by 12 feet (3.66 m). A mixture of species were left including:

western white pine (*Pinus monticola* Dougl.)
western larch (*Larix occidentalis* Nutt.)
Douglas-fir (*Pseudotsuga menziesii* var. *glauca* [Beissn.] Franco)
grand fir (*Abies grandis* [Dougl.] Lindl.)
lodgepole pine (*Pinus contorta* Dougl.)
western hemlock (*Tsuga heterophylla* [Raf.] Sarg.)
western redcedar (*Thuja plicata* Donn)
Engelmann spruce (*Picea engelmannii* Parry)
ponderosa pine (*Pinus ponderosa* Laws. var. *ponderosa*)

The PREF study area was fertilized in the early spring of 1973. The stand had 283 trees per acre (698.8 trees per ha) at the time of fertilization. The mean stand diameter was 3.32 inches (8.43 cm) and the mean height of the stand was 21.56 feet (6.57 m).

METHODS

The DCEF trial was divided into five blocks with three plots each. Three treatments were randomly assigned: no fertilization (treatment 1); urea applied at the rate of 200 pounds of N per acre (224 kg N per ha) (treatment 2); and urea applied at the rate of 400 pounds of N per acre (448 kg N per ha) (treatment 3). A subplot of 0.04 acres (0.016 ha) was established and trees within the subplot were tagged and measured.

A similar design was used at the PREF but with only two treatments. Six plots, each approximately 0.5 acre (0.2 ha) were established and divided into three 2-plot blocks. The treatments, either no fertilizer (treatment 1) or urea applied at the rate of 200 pounds of N per acre (224 kg N per ha) (treatment 2), were assigned at random to the plots in each of the blocks. Similar subplots of 0.1 acres (0.04 ha) were established and trees within them tagged and measured.

Diameter at breast height and total height of the tagged trees were taken in 1973, 1974, and 1977. Periodic mean annual diameter growths and periodic mean annual height growths for the 1973-1977 period were computed for trees alive during 1977.

For each study area, fertilizer treatments were compared and 1973 heights and diameters were used as covariates. Duncan's multiple range test was used to detect which treatment means were significantly different at the 5 percent level. To test the significance of species, a covariate analysis (with species as one of the main effects) was performed. All means used in the comparisons were adjusted for the differences in heights and diameters that existed at the beginning of the study.

RESULTS

Diameter Growth

Periodic mean annual diameter growth at DCEF had a significant ($P<0.05$) 24 percent response to fertilization. Both fertilized treatments had periodic mean annual diameter growth means of 0.36 inch (0.914 cm) (fig. 1). The unfertilized treatment had a diameter growth mean of 0.29 inch (0.737 cm).

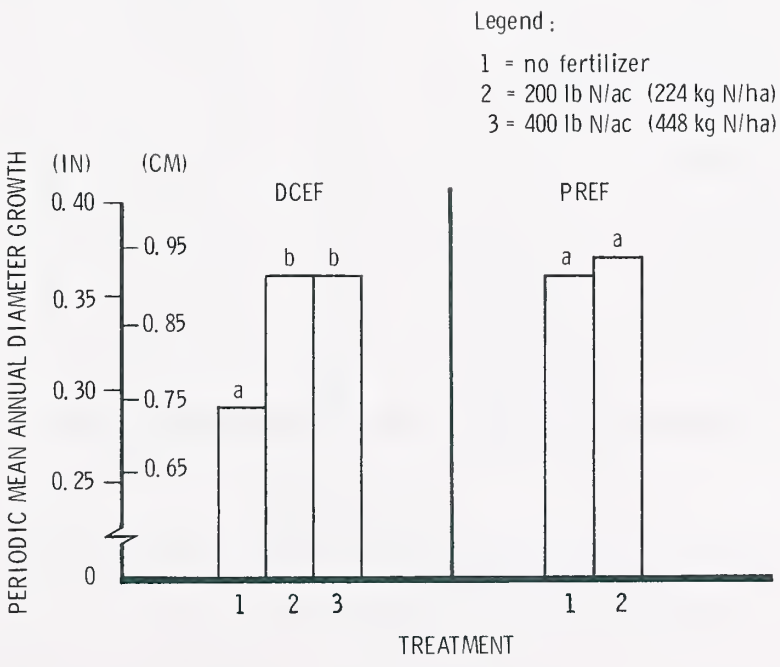

Figure 1.--Periodic mean annual diameter growth by treatment at DCEF and PREF, all species. Different letters indicate significant differences ($P< 0.05$).

No significant response to fertilization was detected in periodic mean annual diameter growth at PREF (fig. 1). The diameter growth mean for the unfertilized plot was 0.36 inch (0.914 cm) and, for the fertilized plots, it was 0.37 inch (0.940 cm).

Height Growth

Deception Creek Experimental Forest periodic mean annual height growth had a 10 percent response to the light application of fertilizer and an 18 percent response to the heavy application. The periodic mean annual height growth for the unfertilized treatment was 1.14 feet (0.347 m) (fig. 2). For the fertilized treatments, 2 and 3, the height growth means were 1.25 feet (0.381 m) and 1.35 feet (0.411 m), respectively. The unfertilized treatment height growth mean was significantly smaller than the two fertilized treatments. The difference between the height growth means for the two levels of fertilization was not significant.

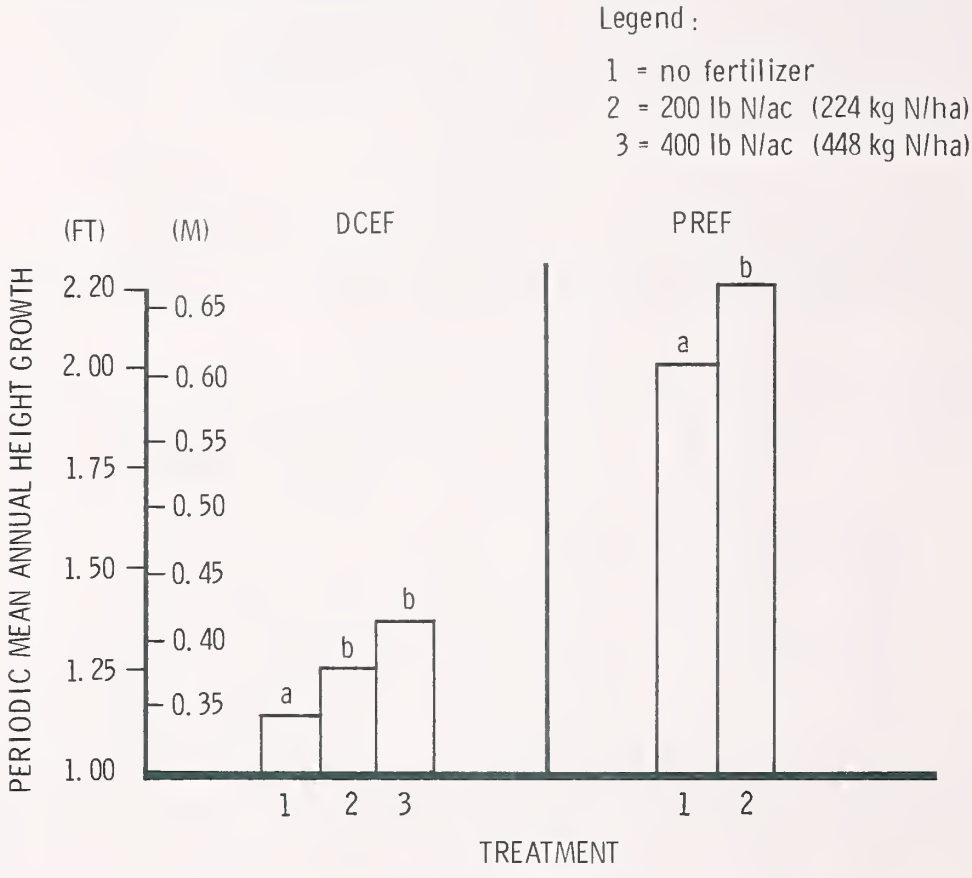

Figure 2.--Periodic mean annual height growth by treatment at DCEF and PREF, all species. Different letters indicate significant differences ($P<0.05$).

At PREF a 9-percent increase in height growth was measured for the fertilized treatment. The unfertilized treatment had a height growth mean of 2.00 feet (0.610 m) and the fertilized treatmennt, 2.18 feet (0.664 m) (fig. 2). The height growth means were significantly different.

Species Differences

The covariate analysis that included species as one of the main effects indicated that species was significant in explaining part of the variation in both diameter and height growth. Therefore, a separate covariate analysis was performed for those species having greater than 10 trees in each of the treatments. At the DCEF, grand fir and western hemlock were the only species having an adequate number of observations for analysis. At the PREF, white pine, western larch and Douglas-fir had sufficient records for analysis.

The DCEF grand fir periodic mean annual diameter growth showed a 30 percent response for the light application of fertilizer and a 26 percent response for the heavy application. The unfertilized treatment mean for diameter growth was 0.27 inch (0.68 cm) compared to 0.35 inch (0.89 cm) and 0.34 inch (0.86 cm) for the fertilized treatments 2 and 3, respectively (fig. 3). The differences in the diameter growth means for the two levels of fertilization were nonsignificant.

Grand fir height growth also had a significant response to fertilization. There was a 24 percent response with the light application of fertilizer and a 45 percent response with the heavy application. The difference between means of the two levels of fertilizer was nonsignificant. The periodic mean annual height growth for the unfertilized treatment was 1.10 feet (0.34 m) (fig. 4). The height growth means for the fertilized treatments 2 and 3 were 1.36 feet (0.41 m) and 1.59 feet (0.48 m), respectively.

No significant differences in either diameter growth or height growth were detected among the three treatment means for western hemlock (fig. 3, 4).

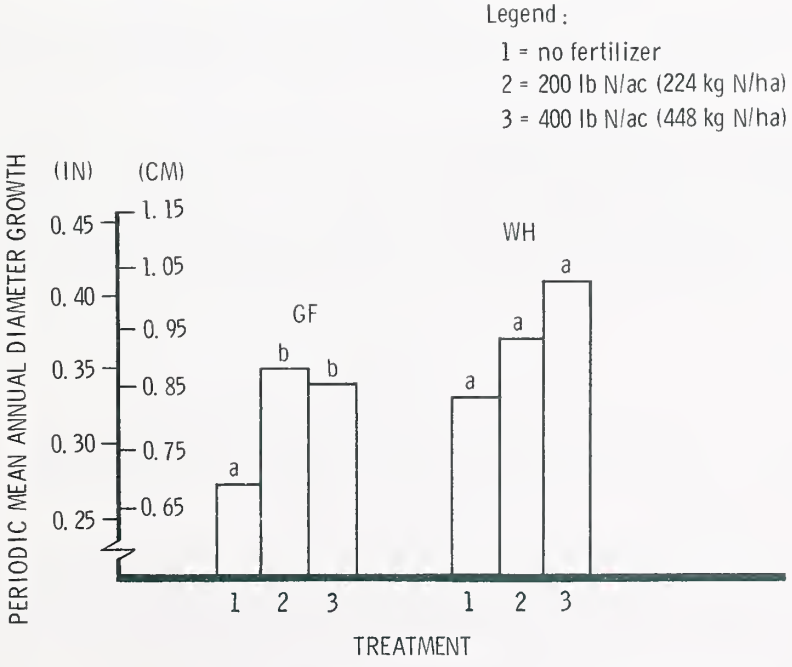

Figure 3.--Periodic mean annual diameter growth by treatment at DCEF. Different letters indicate significant differences ($P<0.05$).

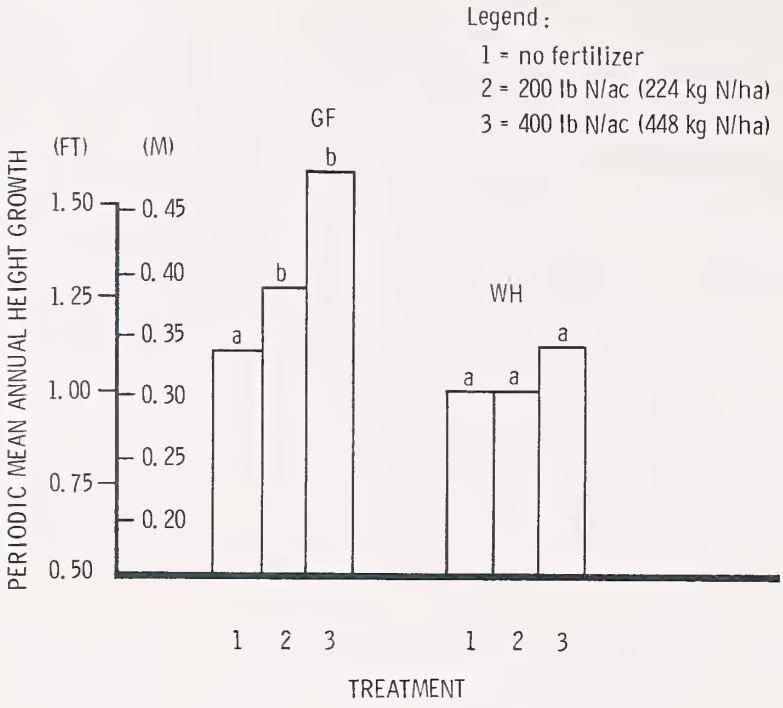

Figure 4.--Periodic mean annual height growth by treatment at DCEF. Different letters indicate significant differences ($P<0.05$).

At the PREF, no significant differences between the unfertilized treatment means and fertilized treatment means for either height growth or diameter growth were detected for white pine or western larch (fig. 5, 6). Douglas-fir had a significant response to fertilization in height growth but not in diameter growth. The Douglas-fir height growth treatment mean for the unfertilized treatment was 1.84 feet (0.56 m) compared to the fertilized treatment of 2.15 feet (0.66 m) (fig. 6).

DISCUSSION

The increase in tree growth due to fertilization can be quite variable. Species composition may influence results, such as the different responses noted at PREF and DCEF. Also the timing of fertilization (spring versus fall) may have contributed to the different responses of the two study areas.

How an individual species responds to the application of fertilizer can also be variable. In our study, the response of grand fir was similar to the findings of Loewenstein and Pitkin (1963). In contrast, our study showed less response to fertilization in white pine than did the findings of Ryker and Pfister (1967).

The significant responses found 5 years following fertilization may not hold in the future or, conversely, more significant differences in tree growth may appear in

the future. This study will continue for at least 5 more years. During this time additional stand and site descriptors will be sought to help explain the different responses to fertilization on the two areas.

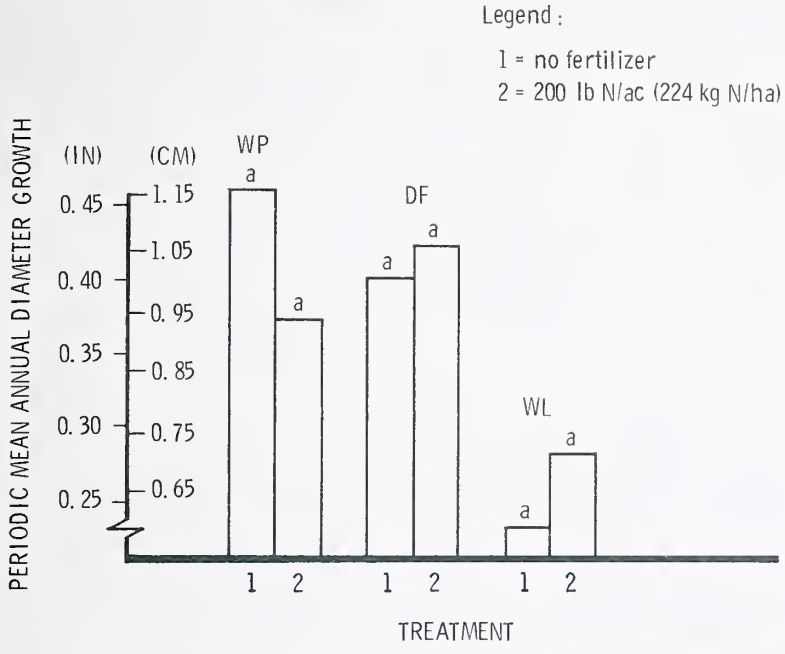

Figure 5.--Periodic mean annual diameter growth by treatment at PREF. Different letters indicate significant differences ($P<0.05$).

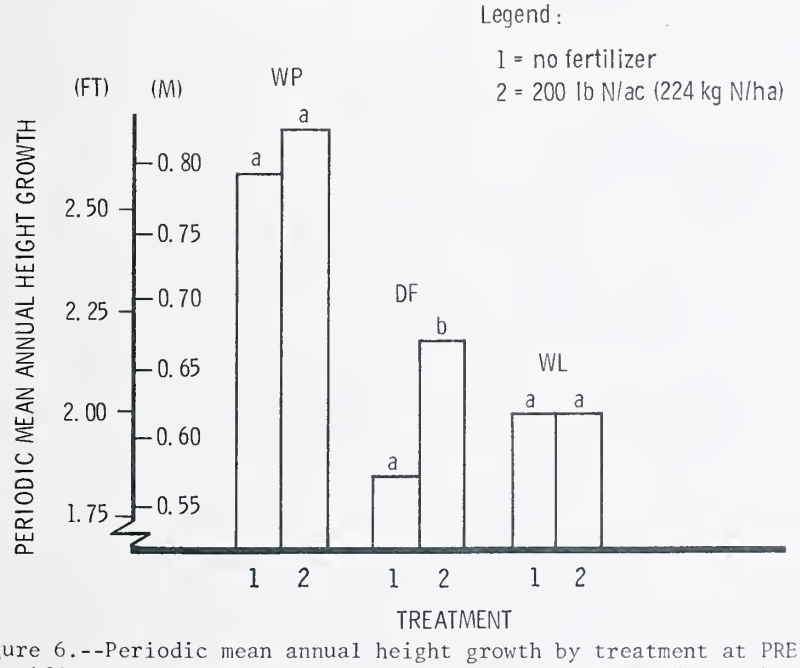

Figure 6.--Periodic mean annual height growth by treatment at PREF. Different letters indicate significant differences ($P<0.05$).

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